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# AGRICULTURAL ENGINEERING

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## Factors Influencing Tractor Development\*

By L. J. Fletcher

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IT IS the purpose of the author of this paper to present a few of the many factors which influence the development of the tractor, with special reference to its adaptation as an agricultural machine. While it may appear that at times certain institutions are unduly credited or discredited, this is most assuredly not the case.

At the 1914 annual meeting of the American Society of Agricultural Engineers, Mr. Patitz of the Allis-Chalmers Manufacturing Company presented a paper entitled "The Rotary Tiller" in which he quoted from a book written in 1850 by C. W. Hoskyns. In this book Mr. Hoskyns classifies the power employed by man as (1) manual, (2) animal and (3) mechanical. He analyzes the peculiar mode of action of each type of power. Manual power is most effective when working in a perpendicular manner or parallel to the backbone of the man. Manual force is most effective in lifting. The direction of animal power is horizontal, and horizontal draft is the only form in which it can be applied. Mr. Hoskyns then points out that mechanical power is totally different from either manual or animal, its favorite motion being frequently circular or rotary; as, for example, the steam paddle wheel, screw propeller, circular saw, threshing machine, cylinder, etc. He raises a question as to why this type of motion should be transposed into draft; in fact, in a number of machines the power is developed, transposed into a horizontal motion, and then again through a ground-

propelled drivewheel of the machine transposed back into a rotary motion. Thus, over seventy years ago a man brought to our attention an inherent weakness in tools which were to be designed many years after his time; in fact, it is only of recent years that engine power has been applied to the operation of machines which were formerly ground driven.

Shall we examine briefly the development of these three kinds of power? History does not tell us when the horse or the ox were domesticated. The reason is that they were domesticated before the beginning of recorded history.

At one time in the development of the human race, the principal vocation of man was agriculture. Agriculture requires power. Before the lower animals were pressed into the service of man, there must have been a need for this labor. In other words, the early farmer produced his own power and created his crude implements to best serve his own peculiar ways of applying force. There undoubtedly arose in him a desire for a better kind of power, which desire, by the way, is present in every user of power to this day. There must have been an interesting time when he was trying out the various animals. He had his problem of producing suitable tools, hitches and harness, of learning to control and care for his new power. Perhaps much of our present profanity originated during this period.

Nevertheless, our ancestors had thousands of years to master this problem, and tools, crops and methods of farming in general were adapted to the more efficient use of animal power.



Among the factors influencing tractor development, not the least in importance is that of providing for the comfort of the operator; if designers could drive their own machines they would know why

\*Fifteenth annual meeting paper.

<sup>1</sup>Pages 57-71 Vol. VIII, Transactions of the American Society of Agricultural Engineers.

We often hear that we are living in the "motor" age. Considering the length of the "animal" age we most certainly are not *in*, but only entering the "mechanical motor" age. This most especially applies to agriculture. We are in far enough to prove the latent desire of man for a better kind of power, but if the tractor manufacturer thinks that the farmer buys the tractor because he loves or longs for it as a tractor, or because a "high-powered" salesman sold it to him, he is mistaken. The farmer does not care what furnishes him power cheapest or produces the largest returns, just so it does. In fact the farmer benefits every time a new kind of power is developed for it gives him a greater choice when he goes shopping.

There has always been opposition to the introduction of new labor-saving machines. The mower, reaper and harvester were destroyed by field hands in England and in this country. The farm laborer fearful of losing his job destroyed the early reapers of Marsh and McCormick. Railroads were opposed and automobiles legislated against. However, in spite of comparative rhetoric, any movement economically sound will prevail.

Someone connected the crankshaft of a portable internal-combustion engine to the wheels of the rig and the tractor was born. It has had all the usual childish diseases as well as a few major operations, but nevertheless has thrived on its diet of kerosene and dust.

The mechanical motor long ago proved its superiority on belt work. It was this demonstration of the steam engine and later the stationary gas engine which, more than anything else, sold the tractor idea to the farmer. If the engine could beat the animal on the belt, why not in the field. How many of the early builders of tractors realized that the tractor must be four times more efficient to compete with the horse in the field than on the belt? The horse power absorbed about one-half the power of the horse so he was fifty per cent penalized on the belt. The early tractor absorbed over one-half the power of its engine in moving itself in the field so it was penalized fifty per cent in the field.

However, there were places in the United States and Canada where the first heavy, slow tractors could be used economically. The early gas tractors differed but little from the steam except in the motive power. Constant and elaborate service was offered and accepted. The farmer cannot alone be blamed for "getting the habit." The automobile had not yet come to pave the way for the later invasion of the hordes. Breakages and delays were many, but the farmer was doing his part in the developing of a tool which later was to serve him. In other words, the tractor was being "domesticated."

The later development of the gas tractor is a different story. Before the manufacturer had a good start in the development in the small tractor, there arose a sudden demand. The war with its attendant high prices for agricultural products, the demand for large production, and the scarcity of farm labor, was the main cause for the waiting line at the delivery door of the tractor dealer. To meet this sudden market, many tractors were hastily designed and tested and then put into production. They were sold because there was a demand for tractors and they looked like tractors.

To reach even its present position the tractor has met many handicaps. There are too many orphan tractors and others whose parents are in very poor health. Early tractor buyers judged a machine by how it would pull and the price. So, in general, tractors were built to pull (when new) and to a price.

Manufacturers early realized the handicap the tractor had by the lack of sufficient knowledge on the part of the operator. They together with the state educational institu-

tions conducted many tractor schools. The obtaining of honest and competent repair work has been and is now one of the biggest problems of the automotive industry. The first small tractors were sold with the understanding that the regular horse drawn tools could be satisfactorily used.

The present tractor situation is due in part to:

1. The great reduction in the price of farm products and the congealed credit.
2. The general tendency to stop buying when prices are lowering.
3. The belief that there are more tractors on the farms of the United States than normal times would have permitted.
4. The many practices which sprang up when tractor sales were easy, such as overselling, neglect of service, poor design or material, and general disregard of the value of the "satisfied customer."
5. The discontinuing of experimental and developing work by many companies during the war period.
6. Very large investments in patterns, special machinery, and stock of parts which must be changed if a radical alteration is made in design.

The above may be said to be the economic phases. The tractor at present may be divided mechanically into three parts: power unit, transmission system and traction devices.

One of the main problems in the power unit is a matter of the vaporization and distribution of our present fuels. Engine builders have repeatedly started the design of a new device for handling the fuels which they find they are called upon to burn. However, by the time the machine which they design is placed in production, the quality of the fuel is so lowered that they simply start over again on another similar job. For a number of years, at least, our fuels will come from petroleum or shale oils. This is almost necessary because of the need for proper lubricant. Engines are now being experimented with which will operate on a crude oil with the lubricating stock removed. This appears to be as far as the oil companies can go in the lowering of quality.

More attention has been given recently to the cooling of the tractor engine. This is evidenced by the many positive types of fan drives on the market, together with construction of cooling systems which provide for the maintaining of a uniformly high temperature without danger of overheating. Because of the increased price of fuel the various heat losses in the motor are being carefully analyzed and attempts made to exhaust at lower temperatures and pressures. Heavier cylinder walls may prevent some loss, but may introduce lubrication troubles.

In the matter of lubrication, considerable attention has been given to the matter of a positive supplying of oil to all of the principal wearing parts of the engine. The placing of an oil pump indicator of a suitable design in the sight of the operator is also a desirable feature.

There is no doubt but what the impulse starter used in connection with a high-tension magneto has wonderfully lessened the starting troubles on tractors. One company manufacturing a tractor in California realized that engines start best when cranked against full compression. To make this possible, they provided a 4-to-1 reduction gear on the end of the crankshaft so that the operator could crank the engine without undue exertion on his part.

Perhaps the biggest advance, however, has been the attention given to the keeping of dust out of the engine. This is indicated by the almost universal use of air cleaners and the present attention given to the determining of most efficient types. Air cleaners are now being placed on both crankcase breathers and carburetor air intake. Provision is also being made on some machines to prevent the dust from getting into the pump stuffing boxes and other places by providing a separate housing for these parts. Valve mechanisms are being enclosed and some engines are now developed

in which the only moving part to be seen is the fan. Overhead valves, owing to the somewhat higher thermal efficiency of engines so equipped, are gaining in favor in tractor construction.

The main advance in transmission systems has been the use of better materials in the gears and better bearings. Attention has recently been given to the forcing of the transmission lubricant to the principal wearing parts rather than depending upon gravity and splash to distribute it. The location and design of stationary attachments should receive more attention on some machines. The absence of a clutch brake on some tractors is also a nuisance and often causes undue wear on the gear teeth. Dust is responsible for many changes in design, being perhaps the main reason for the enclosing of tractor transmission systems.

Of late tractor builders have begun to realize that a human being operates their machines and his comfort should be considered. This is evidenced by a few springs in the seat, and occasionally upholstering and a seat back. Levers are more conveniently located and the steering of the machine made easier.

Undoubtedly one of the biggest single problems facing the tractor designer is the matter of efficient traction. Tests of tractors show that various machines will exert a pull on the drawbar from 30 to 93 per cent of their weight. Often the same machine will vary considerably on different soils. A careful study of the proper lug, or drivewheel and track, design will undoubtedly result in higher tractive efficiency. The swinging drawbar, and high steering bands on front wheels, have aided materially in the control of many of the smaller tractors.

A few general considerations would include the making of tractors requiring fewer special tools for their adjustment. Machines should also be made which will operate for a period of ten hours without replenishing fuel, oil or water to any of the parts of the machine. At the end of the ten hour period the various parts of the machine will receive attention and then be in condition to render another ten hours of service without the little delays caused in turning down grease cups, filling air cleaners or radiators, or making other minor adjustments. Parts of the machine absolutely needing lubrication oftener than every five hours and not automatically cared for should be so arranged that the operator can attend to them from the seat while operating.

The matter of the adjustments of the various parts of the machine should receive more careful attention. It is almost equally undesirable to have no adjustment or too many adjustments on such parts of the machine as the carburetor, clutch, fan drive of a belt, etc. The one adjustment tractor has the advantage of simple and sure adjustments. By that I mean the clutch with but one place to adjust; the carburetor with but one adjustment, and so on.

More consideration is being given each year to the matter of cost of replacing the wearing parts. A careful analysis of the machine will often show parts, which are required as a repair after a tractor has been used for some time, which could be divided into two parts—a small part, the wearing surface, which could be attached to the larger part or the nonwearing.

In the first sixty-five tractors entered in the Nebraska tractor tests, spark plugs were replaced in fourteen, valves were ground anywhere from once to three times in sixteen, forty-one required either minor adjustments such as a clutch and fan belt to taking up bearings, while on forty-six repairs or replacements were made which included everything from cylinder heads, valves and gears to the entire tractor. Those sixty-five tractors should represent at least the average of the factory production, but even in the hands of good operators with twelve hours to limber up and only twenty to thirty

hours of work, the showing does not flatter the industry. Factory tests of tractors should be more often conducted by engineers who are entirely divorced from the designing or production staffs.

There are certain factors which will have more or less of an influence on the future tractor.

Much interest has been displayed in new types of power units. High pressure, condensing steam plants have been developed. However, the more natural trend is toward some form of internal-combustion engine, perhaps of the Diesel type. Electric power will be quickly adapted to agriculture if means for transmitting and directing it without wires are perfected.

Considering the very important part that the operator plays in the success of the tractor, even more attention should be given to real education. Tractor salesmen have too often used the tractor school to cloak sales effort or have informed buyers that no skill was required to operate their particular machine successfully. We occasionally find local dealers who oppose the tractor schools conducted by the universities on the grounds that we are teaching the owners to do certain repair work or make adjustments which they have been paid to do in the past. The farmer must become as intimately acquainted with the tractor as he is with the horse. This Society could very well concern itself with a study of more efficient tractor courses. It is only fair to the tractor as an institution that it be given a just trial, which it certainly is not getting in the hands of the average operator.

Tractor courses should be arranged to provide the maximum of directed practice work in a short time. One week of five eight-hour days of properly organized work will furnish a surprising amount of real ability to do the various necessary jobs on a tractor. Some tractor schools enthuse the student, others show him how, but owing to the expense or trouble, many schools fail to provide enough actual repair work.

No one tractor manufacturer can succeed if all the others fail. Every opportunity for helping each other should be sought after. This applies to standardization of various parts of the machines and to a general, free exchange of information which will help the industry. The tractor must be sold and proven before a tractor can be permanently marketed.

The tractor has suffered because it has been considered a substitute for the horse. This has been carried to the point where tractors were driven with lines. We are gradually beginning to realize that we have here a different kind of power which can and must apply itself to the job in a different kind of way. We are realizing that there is more than one way to obtain the same results in tillage planting or harvesting. Undoubtedly mechanical power has been hindered in its progress by the impossibility of independent thinking in its development. It is common to see combinations of tools or unit tools combining the functions of several former types and occasionally an entirely new tool which is possible only when operated mechanically.

While we call ourselves agricultural engineers, we are mostly informed in the engineering sciences rather than the agricultural. Yet we are all directly connected with agriculture. Designers of farm machinery since its beginning have always taken the problems of the crop as they were and designed the machine to suit all the variations and difficulties presented by the crop. In other words, the engineer did not ask odds of the plant but took it "as is."

We all know that plant breeders have made wonderful changes in our crops by selection, hybridization and the careful development of new varieties. They have made chemical changes in plants such as increasing the sugar content of cane and sugar beets, anatomical changes such as the larger

germ in the corn so as to increase the oil content and make certain varieties more valuable for the by-products so common today. Pasture grass has been developed which would resist the trampling of cattle, and corn so bred that it would throw out a better root system to resist the wind or produce the ears at a convenient height for harvesting.

It is entirely practical and possible to make mechanical changes in plants. If a plant presents difficulties in its present form to the use of mechanical power in cultivating or harvesting, it may be changed. An example of this is found in the development of a type of grain sorghum for California which could be harvested by machinery.

Grain sorghums, including Milo and Brown and White Egyptian corn, have not been popular crops in California because machinery has not been devised which would head them satisfactorily, and it has been necessary to pick the heads by hand at a high cost. Kafir corn, which is grown extensively east of the Rocky Mountains, and which because of its straight heads and uniformity of height, is easily headed with machinery, can not be grown in California because of its late maturity. Kafir ripens in from 160 to 170 days at Davis, while Milo and Egyptian corn ripens in from 120 to 130 days. Previous attempts to introduce Kafir heading machinery in California to head Milo and Egyptian corn have been unsuccessful because these crops are too irregular,

too bulky and too goose necked to go through the machines. In 1917 the University Farm undertook to develop a variety which would ripen early enough to be grown in California, and yet would be uniform enough, straight enough and dwarf enough to be headed by machinery. Five years of continuous hybridization and selection have resulted in the development of "Yolo" which has met all requirements. It ripens at the same time as Milo and may be headed with the small one row Kafir headers or with an ordinary grain header.<sup>2</sup>

This Society should interest geneticists and plant breeders in the development of crops from the mechanical standpoint. If a certain crop is not satisfactorily handled by the present machinery, perhaps the plant could be changed in place of the machine. This might apply to the harvesting of such crops as cotton, beans and peas. If hay loaders knock the leaves from clover or alfalfa hay, why not change the hay so the leaves will stand more shaking while dry.

We are living in the early dawn of the mechanical age. New institutions do not grow overnight. We should judge every new step fairly and not let our enthusiasm accelerate our judgment.

<sup>2</sup>To illustrate how the California farmers welcomed this new crop which could be harvested by machinery, nearly 40,000 acres of Yolo have been planted in California from seed secured from the Agronomy Division at University Farm, Davis. This is the first year that this crop has ever been grown commercially. Indications are that it will become one of the leading cultivated grain crops in the dry farming section of the state.

## Special Features on the Drainage of Irrigated Lands

By Walter W. Wier.

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IN order to have a clear conception of the problems confronting the engineer, the farmer, the investor, and the contractor in relation to the drainage of irrigated lands, one must have had some intimate association with irrigated regions in and beyond the Rockies. I believe that any competent engineer will hesitate to enter fields upon which he is not particularly versed and the more competent the engineer the closer he sticks to those lines with which he is familiar. I am going to assume that the majority of you have had but little irrigation experience and confine your efforts to regions east of the Rockies, and, therefore, some of our western problems may differ from those with which you are most familiar to such an extent that you can be interested for a few minutes in hearing of one or two of them.

The need for drainage in irrigated areas is the result of artificial conditions. Our lands for the most part would require no drainage if they were not irrigated. The magnitude of this need can best be shown when I tell you that probably one-third of the irrigated land in the United States has developed a poor drainage condition as the direct result of irrigation. In California we have very close to six million acres under irrigation and no less than a third of this is now producing as abundantly as it would if drainage conditions were better. You might well ask, why do you continue to irrigate when you see that you are overdoing it? Under conditions where the amount of water that the land receives is under control, don't you know enough to quit when the land is sufficiently wet? The answer is, We do not. Consequently, at the present state of our intelligence,

although we realize the danger, the only thing we do is to try to remedy the evil after it has occurred.

Our irrigated lands are for the most part the alluvial soils of the valleys, and are relatively flat and of even topography. We have soils which have been laid down by stream flow and consist of a great many layers of unconsolidated material which has undergone very little weathering. Under our arid conditions the finer material has not been washed into the subsoil and frequently we find the subsoils of the same or lighter in texture than the surface. In some of our older alluvial soil we find a hardpan as the result of weathering, but this is superficial and is usually underlain with soils similar to the surface.

The bringing in of irrigation water through open canals which invariably follow the high ground has resulted in heavy seepage losses. These losses may often be 50 to 60 per cent of the total water carried. There is an additional loss due to deep percolation caused by more water being applied to the land than the plants and evaporation can take care of.

These water losses from whatever cause pass downward in the soil until they eventually reach the water table. That may be 20 to 40, 80 or 100 feet, depending on the locality. Water was usually not found very near the surface in arid sections. The continued addition of excess water to any area will eventually fill the ground up with water and within a limited period you will find a continuously saturated soil from the bottom up.

This is one point that I want to make clear: In most cases waterlogged areas in irrigated regions mean not an artificial water table above some impervious layer with dry

\*Address before the meeting of the Reclamation Section of the American Society of Agricultural Engineers, Kansas City, September 26, 1922.

soil beneath but the actual rising of the water table from considerable depth up to or near the surface. We have authentic instances of this having taken place at a very rapid rate, sometimes 6 to 10 feet per year. The rate of this rise will depend on two things, the rate at which water in excess of plant requirements is being added to the area and the perviousness of the soil. These two factors are related as the perviousness of the soil partly determines the rate of both seepage and distribution or deep percolation losses.

I have known of irrigated systems where for the first few years seepage losses were from 80 to 100 per cent. I know of places where on account of very sandy soils as much as 14 to 18 acre-feet were used in one irrigation season. Of course, these are extremes but they only go to prove the point. Sometimes the water table is raised above the surface and we have ponds. In other places it may never be so high as to form ponds. Ponds are naturally formed in the low places but not for the reason that we find ponds in such places in humid regions. There they are caused by water seeking the lowest places by flowing from surrounding higher land, but in irrigated regions they form because the ground surface is, in actual elevation, lower than that of the water table. Continued irrigation does not indefinitely raise the water table so that eventually all of the land becomes a lake. We find after a while that the water height becomes more or less stationary because the natural drainage evaporation and plant requirements maintain an equilibrium. We seldom find that the water table is stationary throughout the year as only a few districts keep up the irrigation supply continuously.

All arid region soils are impregnated with alkali salts. This is, of course, only the natural thing to expect. Alkali salts are among the natural constituents of rocks and upon weathering to form soils these salts are liberated. In areas of scanty rainfall and little or no runoff, these salts remain in the soils.

A rising water table dissolves these alkali salts and they are held in solution. Whenever the water table reaches a point so near the surface that capillary action will bring moisture to the surface we find alkali accumulating as a result of evaporation. This feature, the accumulation of alkali on the surface in arid regions, so complicates the drainage problem as to make it different from a humid region drainage problem.

Alkali is of two general types—white and black. White alkali consists mostly (I am speaking now of California) of sodium chloride and sodium sulphate. The chloride is much the more common. Black alkali is sodium carbonate. We think the fellow who gave the name "black alkali" to sodium carbonate used rare judgment in his selection of a name. Sodium carbonate reacts with the humus of the soil and leaves a black stain from whence the name "black," but that is not the only black record which it possesses. I want to tell you a little later about what we have done, or tried to do, with black alkali in California.

Drainage of irrigated lands means the lowering of the water table to such a depth that alkali is prevented from accumulating on the surface by capillary action and evaporation. The water which saturates the soil comes from below and not from the top. I have known of areas being waterlogged that have never had a drop of water applied to the surface. You, no doubt, think of heavy soils in which the downward movement of water is slow as being most in need of drainage, but frequently, in fact generally, the sandy areas through which water percolates most rapidly are the ones requiring drainage first. I do not mean that our heavy soils do not need drainage but they are usually slower to need it. When they do, however, they respond to drainage much more slowly.

In order to lower the water table sufficiently to prevent alkali accumulations, we find it necessary to install drains to much greater depth. We feel that a water table closer to the surface than seven or eight feet is dangerous and, consequently, drains nine and ten feet in depth are not uncommon. About six feet we consider the absolute minimum depth at which a water table should be maintained. With this increased depth, of course, our spacing can also be increased and in sandy soils with drains eight feet deep they may be sometimes one-quarter of a mile apart.

There is, of course, no cut and dried rule for spacing in irrigated sections any more than there is elsewhere as everything depends upon the nature of the subsoil, its texture, presence or absence of more or less previous strata, etc. I do not suppose there is any place where more actual use is made of the United States soil survey reports in planning drainage than in the irrigated areas.

A condition which is of quite common occurrence in irrigated areas is the presence of ground water under pressure. Water entering an area from seepage or otherwise from higher lying land finds its way to some previous layer and after filling this up develops a hydraulic head which forces it upward through the top soils. This pervious layer through which the head is transmitted may be at considerable distance below the surface. The head is often not sufficient to raise the water entirely to the surface and cause springs or even an artesian flow when given free movement as would result from sinking a well into the pervious layer. This pressure, however, is a great source of annoyance as it is very difficult to lower the water table effectively where such exists.

You may install a drain, say, ten feet deep through which a considerable supply of water will flow, yet the ground will be saturated to the surface only a few feet away from the drain. This means that the upward movement of water due to the pressure is greater than the lateral movement due to gravity. I have actually seen a sandy soil where you would expect good lateral movement in which water would stand in an open hole as much as three feet higher than it did in a drainage ditch ten feet away.

The installation of drains either open or tile in a light textured soil where the water stands 3 to 5 feet above the grade line offers some very difficult problems to the contractor. It makes our drainage work expensive. Considerable work is being done. Tile drains that cost from \$50 to \$100 per acre are not uncommon. Of course, both tile and labor are higher on the Coast than in the Mississippi Valley, for instance. On the other hand, our land is more valuable and can stand a greater expense. Drainage of irrigated lands usually means either bringing land *back* into a state of high productiveness or *retaining* it in such a state. As I said earlier, most irrigated land does not need drainage from the beginning and, therefore, it once has a high-producing value to start with. In this respect it differs from drainage in other sections where drainage is expected to bring land into its highest state of productiveness for the first time. I mention this to explain that \$100 per acre for drainage on land worth \$500 per acre in order to keep its value from dropping to \$100 per acre means more than \$100 spent on land worth \$100 before drainage that will be increased to \$500 per acre after drainage.

I want particularly to tell you of a new style of drainage that we are trying out and which gives promise of being a revelation in the drainage of irrigated areas. If the experiments that are being conducted along this line are as successful as they now give promise of being, many of our heretofore difficult problems are solved.

This method of drainage is by pumping from the underground water-bearing strata. I do not want you to understand that we think we have a cure all, and that this method

is applicable for all conditions, but I do believe that there are many large areas of waterlogged lands which can be drained; that is, the water table can be lowered effectively by means of pumps.

There are just two things to be considered, first, find a strata pervious enough to give up comparatively large quantities of water and, second, provide enough pumps to take this water.

In a great deal of the alluvial soils of the West you will find water-bearing sands and gravels at depths varying from sixty to two hundred feet. These layers usually contain what might be called the water table or the point at which the water table existed prior to irrigation.

The lands filled up with water from the bottom, why not drain them from the bottom rather than just skim a little off the top.

If it is possible so to relieve the water-bearing strata that the water taken out must be replaced by other water, the logical conclusion is that there will be a downward movement of all the water above and, consequently, a lowering of the water table. We know that this can happen as it will be simply a reversal of the process that caused the water to rise.

As I stated before, you must pump from some strata that will give up considerable quantities of water and then provide enough pumps to take it. I can easily imagine a well that could be pumped dry and kept dry and yet have no effect on the general ground water level beyond a few feet from the well. This would occur in any well located in strata which gave its water up slowly.

The question of how much water a well should deliver in order to be a success from a drainage standpoint is one which I think can be answered for any locality, the matter of economy of operation, of course, being considered. In the Salt River Valley of Arizona where pumping for drainage has been developed more fully than elsewhere a fairly accurate estimate was made as to the amount of water that it would be necessary to remove from the region. This was determined by ascertaining by various methods the amount of water that was being added annually to the ground water table. Seepage measurements on ditches gave an indication of the amount lost in this way. The amount of water applied to the land for irrigation purposes less the estimated evaporation and plant requirements would indicate the amount lost by deep percolation after being applied. These two losses supplemented by rainfall and storm water from which was subtracted the measured or estimated return flow by natural drainage into canals and streams would indicate the annual addition to the ground water. This could be checked against the rate of rise in the ground water table. For instance, over a period of ten years the ground water table rose say ten feet or one foot per year. Approximately 30 per cent of this space is water. In other words, the ground water supply is being annually supplemented by a depth of 4 acre-inches per acre. None of these measurements are capable of very high precision and require investigation covering long periods by engineers of experience in this line of work. Reasonably authentic records of the rate of rise in ground water are not difficult to obtain.

In the Salt River Valley, for instance, it was estimated that the annual addition to the ground water supply was about 150,000 acre-feet. It would then be obviously necessary to remove at least this amount to maintain an equilibrium. A pumping system was therefore designed having a total capacity of 200,000 acre-feet per year. This is equivalent approximately to 275 cubic feet per second continuous flow. There are about 250,000 acres in the Salt River Valley project. It is obvious, of course, that this flow is not maintained uniformly throughout the year and,

as a matter of fact, it is not necessary that the pumping be continued throughout the year. Drainage by this method has two decided advantages over a gravity system. One is that it can be installed where gravity outlets may be obtained with difficulty, and the other is that the water table can be lowered much lower than it would ever be feasible to do by a gravity system, thus absolutely assuring that there would be no capillary movement of water to the surface, which means alkali accumulations.

There is no reason why a water table could not be kept twenty feet from the surface during the growing season and then the pumps stopped until the water had again reached a height of ten feet during the dormant season. The essential thing is that more water be pumped out than is added, and that during this process the water table at no time must come nearer the surface than some specified distance. It makes no difference whatever how much it is lowered beyond the point.

As a result of these investigations, some 60 feet well pumps were installed. Each well delivers in excess of 2 cubic feet per second, some of them as much as 4 cubic feet per second. A number of wells were drilled which upon testing did not indicate that they would deliver 2 cubic feet per second and they were abandoned. Work similar to this is being experimented with in the San Joaquin Valley of California and I understand also in various other irrigated sections, one in particular in western Nebraska. I know of four or five localities where experimental work is started to test the method. Wells ranging in diameter from twelve to twenty-four inches are sunk until a water bearing strata is reached which normally is between sixty and two hundred feet. Several different makes of pump are being tried and much data accumulated on the drawdown, area affected, amount of water pumped, etc. To me this is the most promising field of endeavor yet undertaken.

We know that in areas where the entire supply of irrigation water is developed from wells that the water table has receded so that sometimes it has been necessary to deepen the wells and lower the pumps. In these sections there is no danger of waterlogging. Should an excess of water be applied it would sink into the soil and there is no danger of it causing injury. As a matter of fact there is not often an excess of water applied under such conditions as it costs money to pump and water is used economically. This brings up a point which is of great importance and worthy of the attention of all engineers in the design of any irrigation or drainage system.

There are thousands of acres of land in all of the western states for which there is no water for irrigation. Yet, in spite of this, hundreds of acres are too wet. Pumping drainage water offers an opportunity for the irrigation of other lands that no other means of drainage provides, and this fact will mean more toward the success of drainage by this method than any other one thing. One very serious objection to pumping as a means of drainage is the assurance that the pumps will be operated sufficiently to bring the best results.

A gravity system of drainage operates all the time, night and day, Sundays and holidays, and will carry water as long as there is any within reach of the drains, but a pump is dependent upon the frailties of human beings for its continued operation. It is extremely easy to stop a pump, and who is there who will stand the temptation to shut down when say 80 per cent of the land is drained, the pumping lift is getting higher and higher and the operating cost and the power bill is ever increasing. I'll tell you who it is. It's the man who must have the water for irrigation. Therefore, I contend that in order to make an entire success of this idea there must be created an urgent and incessant need for the

water. This can be done in two ways: (1) Sell the water to some other area which has none and (2) extend the irrigated area of the project itself beyond the area which can be supplied by gravity water.

I would even go so far as to say that if I had complete control of irrigation affairs I would not permit any irrigation district or company to start irrigation which had in sight sufficient gravity water for all its needs. On the other hand, I would require that at least a portion of the irrigation supply be recovered from the underground sources by pumping. In this way, and in this way alone, do I see the ultimate success of our drainage problems and at the same time the extending of our irrigated areas to the greatest possible extent. However, as it is very apparent, I do not have any such control and I am, therefore, interested primarily in the drainage of lands which have been overirrigated.

As I mentioned before, the Salt River Valley offers the only real example of the pumping idea and although I have not had an opportunity to visit this section personally for about three years (which was during the period of installation of the pumps) I am informed by those who have visited it that great success is being had. At one point in the San Joaquin Valley, near Manteca in the South San Joaquin Irrigation District where five pumps were installed experimentally, the farmers are now complaining that their crops are dying on account of lack of water. This was in a section where the water table was very high and no irrigation water was used. These crops were shallow-rooted because they had grown on land having a high water table and naturally when the water was taken away they were left high and dry. To me this is very encouraging. The remedy for this is irrigation, and that is exactly what it should be. We know full well that proper irrigation produces better and larger crops than any other system of providing moisture. The matter of cost must, of course, be considered but from our limited experience that is going to be to the advantage of pumping over gravity systems. A good heavy producing well, one likely to have considerable influence on the ground water, can be installed for from \$3000 to \$5000 which includes a reasonable amount of discharge line. It is difficult offhand to give any fairly accurate estimate of the size of pump required as it depends altogether on the kind of well that is found. No two wells are alike. After testing them a pump is designed to fit them. It may be an 8 or 10-inch pump with a 35 or 40-horsepower motor, or it may be a 15 or 18-inch pump with a 75 or 100 horsepower motor. It is also difficult to ascertain the distance apart that pumps should be located. Obviously it will take more pumps per acre on a small area than on a large one, especially if the small area is in the midst of a high water table area.

For areas of a few thousand acres, one might expect it would be necessary to have a pump for each one-fourth section, while pumps much farther apart would suffice for an area of 100,000 acres. Nor is it supposed that they would be located at regular intervals in either case.

If I were to make a guess, I would say that for a large area the first cost of pumps would be below \$10 per acre, whereas for a small area it might be two or three times that amount. Unfortunately, however, the operation cost of pumping is considerably more than the operating cost of a gravity system, and even though the first cost is very much less fifteen or twenty years might easily find the pumping more expensive. On the other hand, I do not anticipate that fifteen or twenty years will find many pumping systems in which the water is wasted into the natural drains, but will be used for irrigation elsewhere. This then would lessen materially the drainage cost.

Summing up the pumping situation, it appears to me to

be a logical and entirely feasible method of reducing the water table over many areas which have poor drainage as a result of irrigation.

The essential points are:

1. Find a well or series of wells capable of delivering a good supply and put on pumps of sufficient size to take it out.
2. Find a continuous use for the water.

The advantages are:

1. It is possible by this method to lower the water table below any depth feasible by a gravity system. This assures the success of alkali prevention.
2. It makes more available the water developed than would be possible by a gravity system where it would be necessary in most cases to pump it on to higher lands.
3. The first cost is considerably less than gravity drainage.

4. It is applicable where gravity outlets are unavailable.

The disadvantages are:

1. The dependence of pumps on humans for their continued operation.
2. The operating costs.

Now I would like to mention some of our alkali work in California which I hope will be of interest.

Some forty years ago Dr. Hilgard began studying alkali and predicted the increase in damage that would result from the continued use of excessive amounts of irrigation water. He recommended drainage as a means of reducing the water table and thereby eliminating the direct cause. He advocated flooding the land after drainage to leach out the alkali and re-distribute it throughout the soil column. He also advocated the use of gypsum on black alkali land in order to change it over to the more leachable sulphate form.

That tells the whole story today. Those are fundamentals, and except for improved methods there has been but little advancement. Hilgard was not an engineer but a soil chemist and physicist and, consequently, made but few suggestions about the design of drainage systems. He did know, however, that it was necessary, first, to lower the water table. I have just finished a very feeble attempt to describe the newest ideas on how to do that.

Flooding land after drainage in order to wash the surface accumulations of alkali back into the soils and out through the drains is being practiced today about as advocated forty years ago. It is a well known fact that drainage alone, the lowering of the water table alone, is not sufficient to bring a highly alkaline tract back into productiveness. It is necessary next to remove the alkali which was already accumulated. The process is to prepare the land so that it can be flooded to a depth of six inches to one foot and hold it under water for a period. The depth of submergence, length of time, and related subjects are dependent upon the soil type and the amount of alkali present. Too often engineers think they are through with drainage when they have accepted the drains from the contractor. That is not true; he has not finished until the land is actually brought back to productiveness. I know of instances where the lack of this final step has meant the difference between success and failure of a drainage system.

The farmer thought that when the drains were installed he should have drainage. The engineer thought the same thing or rather thought that it was up to the farmer to do the rest, whereas, engineering advice and assistance is just as necessary in this last step as in the design of the system.

I know of one drainage district in California which, before the land became waterlogged, was fine alfalfa, vineyard, and truck land. It became waterlogged and alkaline and the entire area was used as salt grass pasture. Finally a tile drainage system was installed at a cost of about \$75 an acre

and the water table lowered to about eight feet. At this point the district thought that it was through with the services of its engineer and he was discharged. Three years afterward the land was not producing as much as it did before it was drained as the salt grass had died because of the removal of the moisture and the resulting pasture was not as good. The trouble was that the land had to be irrigated, reclaimed from alkali, and put back into alfalfa. This is an engineering job and they had no engineer to tell them how.

I will take now the black alkali or sodium carbonate problem. Hilgard probably was right, or at least partly so, when he advocated the use of gypsum on black alkali land, but either because he failed to appreciate the importance of black alkali or the practical difficulties in handling it he did not give us much real practical information.

I might add right here what may seem to you to be a bold statement, but which I think is substantially if not actually true. There never has been a black alkali area reclaimed successfully. There have been numerous attempts but for one assigned reason or another they have not been successful. In 1912 the University of California took a bad piece of black alkali land, 160 acres in all, in which it was thought to be possible to eliminate all of the reasons which had been assigned for failures in other sections, such as insufficient depth of drainage, feeble attempts at flooding, lack of interest, etc. It was drained with tile, flooded, and everything else done which was thought necessary and, furthermore, we had almost complete control of the operations. The tract is not yet producing as good crops as it did before it became alkaline. The University after five or six years began to get excited about the matter and started more complete investigations, with the result that we discovered that we were tackling something that had never been done, the complete reclamation of black alkali land.

I do not mean to convey the idea that it can not be done, but rather so far as I have been able to learn it never has been done.

We then took a small area, about seven acres, in nine three-quarter-acre plots of the worst land in the quarter section that had been tile drained and proceeded to treat it intensively. The tract was carefully levelled, plowed, and prepared as a seedbed. The soil was very carefully sampled and tested for alkali, several hundred samples being taken. Gypsum was then applied at the rate of three tons and six tons per acre to three plots respectively, the other three remaining as checks. The nine plots were then flooded to a depth of about one foot. When the water had disappeared, which required a couple of weeks, the plots were cultivated and flooded again. This was repeated a third time. Barley was then planted and the yield plotted and compared with the yield that had been grown and plotted previous to the treatment.

This process has been repeated with the addition of more gypsum to three of the plots and sulphur added to additional plots. The soil sampling, crop yields, and all other data has now been obtained for three years.

Briefly, we have very greatly improved all of the plots, those to which only water was added as well as those to which gypsum was added. The balance, however, is in favor of the gypsum when only yields of barley are considered, but when cost is considered which, of course, is very necessary when any attempt is made to apply the remedy generally the whole thing has not been a success. Even those plots upon which the most gypsum was applied are not yet 100 per cent perfect. The result is, we do not yet know how to treat commercially black alkali land in order to reclaim it. I feel certain that this is the most intensively and thoroughly studied piece of black alkali land in the United States. I am certain, however, that more has been

learned about black alkali, its occurrence, its effects and its treatment within the past three years than had heretofore been known.

You might think that I am getting beyond the realm of the engineer but I think otherwise. It is an engineering problem just as much as the building of a bridge. The engineer might just as well say "I've built a bridge; what do I care whether it's fit for travel or not?" The engineer is vitally concerned as to whether a piece of land on which he has placed tile drains will grow anything or not. We are certain of this one thing regarding the reclamation and the prevention of alkali. It is necessary as the first step to lower the water table or to keep it beyond capillary reach of the surface.

I have rather briefly to describe some of the difficulties encountered in removing alkali from the surface of land after it has once accumulated. If the old adage of an "ounce of prevention being worth a pound of cure" was ever true, it most certainly applies to irrigated lands.

In closing, let me repeat that the only true remedy for alkali and waterlogged conditions is to prevent its occurring. This brings us back again to the pumping idea. Every sound irrigation development in the future will be based on obtaining at least a portion of its water from underground sources. New developments which have no present prospect of gravity water can succeed if the older waterlogged areas will permit pumping, and the older waterlogged areas are doomed to failure unless they do pump from their ever increasing underground supply; thus, the two work hand in hand to the betterment of all.

### Substitute for Iron Pipe

**A**CHEAP bituminous clay pipe, to be used in the place of cast iron pipe, has been devised by the Carnegie Institute of Technology. The new form of piping, it is expected, will be as satisfactory for drainage and sewerage purposes as the more expensive cast iron pipe which has been the only variety available up to the present.

The chief difficulty in the search for a substitute for cast iron pipe has been to find a method of joining the ends of the substitute piping without leakage. Various bituminous cements were recommended for this purpose but early experiments showed that they were unable to overcome the difficulty. An entirely new joining technique in the use of these cements has now been devised. Four important points have been established: (1) the joining of the pipe can be effectively accomplished by the use of a proper bituminous compound; (2) the joints made in this manner will withstand any pressure that the pipe itself will stand; (3) a pipe line, joined in this manner, can be thrown out of alignment without causing leakage at the joints; (4) leaks due to poor workmanship can be prepared easily and quickly.

### Recommended Width of Roads

**A**MINIMUM width of 18 feet for hard-surface roads is recommended by the bureau of public roads of the United States Department of Agriculture. The maximum width of truck body generally permitted is 8 feet, and  $5\frac{1}{2}$  feet is the ordinary clearance width of automobiles. At an average speed of 30 miles an hour, it is unreasonable to expect the driver of an automobile to drive with the wheels closer than  $1\frac{1}{2}$  feet to the edge of the pavement. For trucks at an average speed of 15 miles an hour, this distance should not be less than  $1\frac{3}{4}$  feet on account of the great width of the rear wheel. Three feet seems to be a minimum safe clearance between bodies. Inasmuch as a certain amount of truck traffic is to be expected on all main country roads, the minimum width of surface should be 18 feet to provide these clearances when an automobile meets a truck.

# Agricultural Engineering Development

A Review of the Activities and Recent Progress  
in the Field of Agricultural Engineering Investi-  
gation, Experimentation and Research

*Edited by R. W. Trullinger*

Mem. A.S.A.E. Specialist in Rural Engi-  
neering, Office of Experiment Stations, U. S.  
Department of Agriculture

**A SOURCE OF LEAD CONTAMINATION OF CISTERN WATER,** L. Greenburg, [Public Health Reports (U. S.) Washington, D. C., 37(1922), No. 30, pp. 1825-1829.]

This is a report of an examination of the drinking water supply system at the U. S. Fish Hatchery Station, Gloucester, Massachusetts, for possible sources of lead contamination, in which it was found that the flashing on the roof of the hatchery building, from which rain water is collected and then used for drinking purposes, is the source of the lead found in the water under investigation.

**RECENT DEVELOPMENTS IN WARM AIR FURNACE HEAT-  
ING,** F. R. Still, [Journal American Society Heating and  
Ventilating Engineers, 28(1922), No. 4, pp. 385-395, figs. 5.]

A summary is given of some of the developments of the warm air furnace heating research conducted at the University of Illinois, and of some of the standard practices developed by the National Warm Air Heating and Ventilating Association. Formulas and data are given for determining the size of the leaders or pipes from the furnace to the various ducts and registers and for wall stack sizes. Data are also given on circulation stimulators and related factors.

**FARM BUILDING PLANS AVAILABLE,** G. A. Fain and W. E. Broach, [Georgia Agricultural College Extension Bulletin, Athens, July, 1922, pp. 4.]

The farm building plans available at the Georgia State College of Agriculture for the farmers of Georgia are listed. These include general purpose, beef, hog, dairy, hay, and tobacco barns, sweet potato curing houses, dipping vats, cold storage plants, smoke houses, sewage disposal systems, poultry houses, farm houses, implement sheds, and miscellaneous structures.

**R EPORT ON THE MOTOR TRACTOR TRIALS ORGANIZED BY  
THE MINISTRY OF AGRICULTURE,** A. T. McKillop, (Cairo: Egypt Minister of Agriculture 1921, pp. 55, pls. 26.)

The results of two different sets of motor tractor trials conducted on medium soil of the Southern Delta and on heavy soil of the Northern Delta regions in Egypt are presented and discussed. Thirty different tractors were tested, among which were a number of American manufacture. A striking feature of the results was that apparently on the soils of Egypt the crawler type of tractor is not so efficient as the wheel-driven type. The highest all-around efficiencies were given by wheel-type tractors, and the best all-around results were given by a 20-horsepower machine. Considerable detailed data of results of operation are presented.

**ELECTRIC POWER FOR MILKING PLANTS,** L. Birks, [New Zealand Journal of Agriculture, Wellington 23(1921), No. 2, pp. 99-103, figs. 2.]

The results of a series of meter tests made on five typical milking plants in the Canterbury district of New Zealand are reported and discussed.

It was found that, while a 3-horsepower motor was employed in each case, the tests indicated that a 2-horsepower motor would be sufficient for at least four out of the five and probably, with a little improvement in the conditions of operation, for the fifth as well. This is considered important from the economic standpoint, as the idle magnetizing current for a 3 horsepower motor would be approximately fifty per cent greater than for a 2 horsepower motor, and this magnetizing current must be supplied continuously as long as the motor is running whether loaded or not. The power used was found to be very variable and apparently depends much more on the efficiency of the plant and the method of use than on the actual number of cows milked. A record of the power consumption of four of the plants for twelve consecutive months is also presented.

The opinion is expressed that the most effective application of electric power to milking machine work under New Zealand conditions will consist of a small self-contained outfit comprising an electric motor, vacuum pump, cream separator, small water supply pump, and a 10-gallon water cistern with the necessary switch gear, all mounted on a compact hardwood base plate.

It is considered probable that if more consideration were given to proper alignment of machines and shafting and sonority of foundations, a higher efficiency would be obtained, since the present tendency is to erect the plant in a lightly built shed attached to the cow stall, much to the detriment of the efficiency.

**R EPORT OF THE WATER CONSERVATION AND IRRIGATION  
COMMISSION FOR THE YEAR ENDED JUNE 30, 1921.** [New South Wales Water Conservation and Irrigation Commission Report, 1921, pp. 32, pl. 1.]

This report deals with irrigation areas established and controlled by the state, irrigation schemes under consideration, water conservation works constructed by the state but administered by local trusts, national works maintained by the commission artesian and shallow boring and licensed works for stock and domestic water supply, irrigation, and other purposes.

**B RACED RAFTER BARN FRAMING,** H. P. Twitchell, [Ohio Agricultural College Extension Bulletin 17(1921-22), No. 8, pp. 20, figs. 22.]

This bulletin discusses the braced-rafter method of barn framing and includes numerous diagrammatic illustrations and detailed drawings. The braced-rafter type of barn construction is recommended for barns not exceeding 36 feet in width, 18 feet in height from grade line to plate, and not having threshing floors. The 34-foot width is considered particularly suitable for dairy barns. This type of barn framing is said to require less lumber and is stronger and more rigid than the timber frame construction. It uses only stock sizes and lengths of lumber, requires only a few men to construct and erect the frame, and has a large unobstructed mow.

# A. S. A. E. and Related Activities

## A.S.A.E. 1923 Officers

THE election of officers for 1923 of the American Society of Agricultural Engineers has resulted as follows:

PRESIDENT, E. W. Lehmann, professor of farm mechanics and head of the department at the University of Illinois.

FIRST VICE-PRESIDENT, A. H. Gilbert, chief engineer, tractor department, Rock Island Plow Company.

SECOND VICE-PRESIDENT, R. W. Trullinger, specialist in rural engineering, Office of Experiment Stations, U. S. Department of Agriculture.

TREASURER, Raymond Olney, who is also secretary of the Society.

COUNCILLOR (for three years), William Aitkenhead, professor of agricultural engineering and head of the department at Purdue University.

NOMINATING COMMITTEE, W. B. Clarkson chairman, A. P. Yerkes, and C. O. Reed.

The officers will assume their duties at the close of the next annual meeting which will be held December 27, 28, and 29, 1922. In the meantime, the new president will appoint committees for the ensuing year so that they will be immediately ready to function following the annual meeting in December.

## 16th Annual Meeting Program

THE program for the sixteenth annual meeting of the American Society of Agricultural Engineers is practically complete and promises to be one of unusual interest and value to the agricultural-engineering profession. The meetings committee deserves a great deal of credit for this very constructive program. The meeting is to be held at St. Louis, Missouri, December 27, 28, and 29, 1922.

### MORNING SESSION—WEDNESDAY, DECEMBER 27

9:00 A.M.—Registration

President's Address

*Reclamation Section Program*

10:45 A. M.—Address

A. Lincoln Fellows, senior irrigation engineer, U. S. Department of Agriculture.

### AFTERNOON SESSION—WEDNESDAY, DECEMBER 27

*Reclamation Section Program*

2:00 P. M.—“Land Clearing” (The effect of fire in land clearing operations—brush plowing and other methods of handling brush—stone removal—decay of stumps—land clearing explosives.)

John Swenehart and members of the Land Clearing Committee, “The Economic Effect of Further Reclamation and Colonization of Agricultural Lands,” H. B. Walker, chairman agricultural engineering department, Kansas State Agricultural College.

Report of the Colonization Committee, O. V. P. Stout, Dr. Elwood Mead, H. B. Walker.

“The Demand for the Agricultural Engineer in the Operation and Development of Reclamation Projects,” David Weeks,

department of rural institutions, University of California.

### EVENING SESSION—WEDNESDAY, DECEMBER 27

*College Section Program*

6:00 P. M.—“Vocational Education in Agriculture”

C. H. Lane, chief, agricultural education service, Federal Board for Vocational Education.

“The Problem of Electricity Energy Use on the Farm,” J. C. Martin, Western editor “Electrical World,” and member of the Rural Lines Committee, National Electric Light Association.

“The Psychological Tests at Ohio State University,” F. W. Ives, chairman, agricultural engineering department, Ohio State University.

### MORNING SESSION—THURSDAY, DECEMBER 28

*Power and Farm Equipment Program*

9:00 A. M.—“Air Cleaners for Tractor Engines,” A. H. Hoffman, University of California.

“Influence of Wheel Equipment on Tractor Efficiency,” E. S. Patch, experimental engineer, Dayton Research Laboratories.

“Field Experience as a Scientific Factor in the Design and Improvement of Farm Machines,” G. B. Gunlogson, research engineer, J. I. Case Threshing Machine Company.

“Haying Machinery,” Wallace Thomas, The Thomas Manufacturing Company, Discussion by F. N. G. Kranick.

### AFTERNOON SESSION—THURSDAY, DECEMBER 28

(Four section programs going on simultaneously.)

2:00 P. M.—*Reclamation Section Program*

“Land Clearing” (Mechanical stump pulling outfit—decay of brush and use of land when large brush is plowed down—miscellaneous land clearing devices.) John Swenehart and members of the Land Clearing Committee.

Report of Committee on Soil Erosion, Q. C. Ayres and members of Committee.

“Drainage Engineering” (Drainage assessments—laws—standard tile sizes—specifications—design—fees.) E. R. Jones and members of Drainage Committee.

2:00 P. M.—*Farm Structures Section Program*

Report of Committee on Farm Building Design Tests of Self-Supporting Barn Roofs. W. A. Foster, agricultural engineering department, Iowa State College; A. W. Clyde, agricultural engineering department, Iowa State College.

Report of Committee on Sanitation, “What Experiment Stations are Doing Along the Line of Septic Tank Investigation,” E. W. Lehmann, professor of farm mechanics, University of Illinois.

Report of Committee on Farm Building Equipment.

Report of Committee on Ventilation. “Ventilation on New England Dairy Barns,” “Ventilation of Tobacco Sheds,” M. A. R.

Kelley, agricultural engineer, U. S. Department of Agriculture.

2:00 P. M.—*Farm Power and Equipment Section Program*  
Report of Testing and Rating Committee,  
O. W. Sjogren, University of Nebraska.

Report of Committee on Motor Fuels, A. H. Gilbert, Rock Island Plow Company.

Left-Hand Plow Investigation, G. W. McCuen, Ohio State University.

"Grain Handling Equipment," Robert H. Black, in charge of grain cleaning investigations, U. S. Department of Agriculture.

"Farm Lighting," I. W. Dickerson, agricultural engineering editor.

"Tractor Testing and Rating," O. W. Sjogren, University of Nebraska.

Disk Harrow Investigation, E. V. Collins, Iowa State College.

2:00 P. M.—*College Section Program*

"Standardization of Farm Motor Courses," W. J. Gilmore, University of Oregon. Discussion led by C. W. Smith, University of Nebraska.

"Extension Work in Agricultural Engineering," E. J. Stirnimann, University of California.

"El Instituto Experimental de Mecanica Agricola de la Facultad de Agronomia de Buenos Aires—Lu Organization—Lu Labor," Dr. Marcelo Conti, Director.

Report of Extension Committee, F. W. Ives, Chairman.

Report of Extension Committee, F. W. Davidson, Chairman.

Report of Teachers Directory Committee, H. H. Musselman, Chairman.

4:00 P. M.—Business Meeting of the Society

EVENING SESSION—THURSDAY, DECEMBER 28  
7:00 P. M.—Annual Banquet

MORNING SESSION—FRIDAY, DECEMBER 29

*Farm Structures Program*

9:00 A. M.—"Building the Modern Rural Home"  
K. J. T. Ekblaw, Portland Cement Association.

"Making the Farm House a Home," Joanna Hansen, Iowa State College.

"Lessons to be Learned from Failures of Farm Buildings in a Tornado," Virgil Overholt, agricultural engineering department, University of Ohio.

"Some New Ideas in Group Planning of Farm Buildings," F. W. Ives, professor of agricultural engineering, University of Ohio.

"Poultry Houses that Have Made Good in Indiana," C. A. Norman, extension agricultural engineer, Purdue University.

AFTERNOON SESSION—FRIDAY, DECEMBER 29  
2:00 P. M.—Trips of Interest—Local Committee

2:00 P. M.—Council Meeting

### Reclamation Men Meet

THOSE members of the Reclamation Section of the A. S. A. E. who were in attendance at the National Drainage Congress in Kansas City, Missouri, during its recent convention, held a "get together" luncheon in Convention Hall, September 27th.

Following the luncheon an enjoyable hour was spent when each of the twenty members present introduced himself with a few remarks of general interest. Walter W. Wier of the University of California spoke briefly on the drainage problems connected with irrigation lands and made

special reference to pumping from wells as a means of lowering the water table on such areas. Prof. W. L. Powers of the Oregon Agricultural College acted as chairman of the meeting.

### Personals

JAY BROWNLEE DAVIDSON, professor of agricultural engineering and head of the department at Iowa State College, is a charter member of the American Society of Agricultural Engineers, was its first president (1908), and is at present a member of the Council and chairman of the Farm Power and Equipment Section. He organized the department of agricultural engineering at the Iowa State College, the first of its kind, and established the first four-year college course leading to the degree of bachelor of science in agricultural engineering. Prof. Davidson has well earned the title "dean of agricultural engineers," which he has been called.



JAY BROWNLEE DAVIDSON

Prof. Davidson was born and reared on a Nebraska farm and graduated from the University of Nebraska in 1904 with degree of bachelor of science in mechanical engineering; in 1914 he was awarded the professional degree of agricultural engineer by that institution. Following graduation he was successively assistant in the experimental department of Deere & Company, instructor in farm mechanics at the University of Nebraska, and machinery expert for International Harvester Company. In 1905 he was appointed assistant professor of agricultural engineering at the Iowa State College and in 1907 was promoted to full professorship. From 1915 to 1919 he was professor of agricultural engineering and head of the department of the University of California. Again in 1919 he became head of the agricultural engineering department at Iowa State College.

Prof. Davidson is the author of a large number of books, bulletins, and articles on various phases of agricultural engineering. He is author of Iowa agricultural experiment station Bulletin No. 141, entitled "Modern Silo Construction;" co-author with L. W. Chase, of "Farm Machinery and Farm Motors," a book published by Orange Judd Company; author of "Agricultural Engineering," published by Webb Publishing Company; and also author of a paper entitled "Influence of Speed on the Draft of a Plow," published in Vol. XIII of the Transactions of this Society. He is senior author of the following bulletins published by the Iowa agricultural experiment station: Bulletin No. 93, "Relative Value of Alcohol and Gasoline for Fuel and Light;" bulletin No. 100, "Modern Silo Construction;" bulletin No. 117, "The Iowa Silo;" bulletin No. 132, "Poultry House Construction;" bulletin No. 166, "Community Hog Houses;" and of the California agricultural experiment station circular No. 173, "The Wood Hoop Silo." He is also associate author of two bulletins issued by the Iowa agricultural experiment station, "Creamery Organization and Construction" and "Movable Hog Houses."

He has designed several pieces of agricultural engineering apparatus, including the Iowa intergrating traction

dynamometer described in the Transactions of this Society, Vol. IV.

Prof. Davidson is a member of the following scientific, engineering and agricultural honorary societies: Sigma Xi, Sigma Tau, Phi Kappa Phi, Alpha Zeta, and Tau Beta Pi.

He was one of the judges in the Winnipeg motor competition of 1909, 1910, 1911, and 1913.

He is a member of the Society of Automotive Engineers, president of the Ames Engineering Club, and member of the Ames city council.

R. H. DRIFTMIER, assistant professor of agricultural engineering at the Kansas State Agricultural College, has recently made a preliminary investigation of a new type of kaffir corn header which is being manufactured by the John Deere Plow Works.

F. W. DUFFEE, in charge of tractors and farm machinery in the department of agricultural engineering at the University of Wisconsin, and JOHN SWENEHART have recently worked out a design for a brush breaking plow for turning underbrush, roots, and other accumulations on cut-over land. Field tests show that the improvement is entirely practical and should effect a considerable saving in time and cost of work. A full report of this improvement will be made at the annual meeting of the Society in December.

M. E. JAHR, for eleven years associated with the farm mechanics department of the University of Illinois and acting head of that department for some time, has been appointed assistant land clearing specialist in the department of agricultural engineering at the University of Wisconsin. Mr. Jahr's time will be devoted to extension and research work in land clearing reclamation work. He has spent several months in field work with land clearing crews of Wisconsin.

M. A. R. KELLEY, agricultural engineer for the U. S. Department of Agriculture, received the professional degree of agricultural engineer from the Iowa State College last June; Mr. Kelley is a graduate agricultural engineer from that institution. Recently Mr. Kelley made an extended trip through the northeastern portion of the United States for the special purpose of making a study of the different variety of Illinois, reports two additions to the staff of his systems of ventilation used in dairy barns, which gave him an opportunity to study the development of farm buildings from the Colonial period to the present time. Early in the summer he made a trip through Tennessee and Kentucky studying the construction of tobacco barns and the proper curing of tobacco.

E. W. LEHMANN, professor of farm mechanics, University of Illinois, reports two additions to the staff of his department. These men are FRANK P. HANSON and R. E. KELLEHER, both graduates in agricultural engineering at the Iowa State College. Mr. Hanson will devote part of his time to experiment station work and part to extension work. Mr. Kelleher's time will be devoted equally between station and college work. The experiment station and extension work in agricultural engineering at the University of Illinois is just being developed and projects are being organized.

W. H. MCPHEETERS, extension farm engineer at the Oklahoma Agricultural and Mechanical College, is doing a valuable work in the State of Oklahoma in connection with the terracing of rolling and hillside farms in Oklahoma. The work is comparatively new in the state and in order to arouse people to the importance of it he has employed several methods, which include holding demonstrations on various farms over the state in cooperation with the county agent; interesting groups of farmers to purchase levels and do the

work themselves after being taught how; terracing demonstrations at fairs:—a new method which will be tried in the near future is the organization of boys clubs in farm engineering, which will make terracing their first problem. In addition to terracing activities Mr. McPheeeters is carrying on a number of demonstrations in drainage, irrigation, farm and farm homestead plans, and is making plans for various farm buildings and sending blueprints to the farmers to encourage the building of better farm buildings.

STANLEY F. MORSE, consulting agricultural engineer of New York and New Orleans, has been retained by the United Fruit Company to make a complete agricultural inspection of its sugar estate in Cuba comprising nearly 90,000 acres.

E. S. PATCH was recently transferred from his position as engineer of tests at the Samson tractor division of the General Motors Corporation to the General Motors Research Corporation, Dayton, Ohio.

H. B. ROE, professor in charge of drainage in the agricultural engineering division at the University of Minnesota, is preparing for publication in technical form the results of farm drainage investigations at the Minnesota station covering the last fifteen years. He is also preparing a series of popular circulars and bulletins covering the field of farm drainage in Minnesota, which promises to be a real service to the farmers of that state.

B. B. ROBB, associate professor of rural engineering at the New York State College of Agriculture at Cornell University, has been granted a leave of absence and has entered the graduate school of education at Harvard University, where he is working for a doctor's degree, majoring in methods of teaching.

CHARLES E. SEITZ, professor of agricultural engineering and head of the department at the Virginia Polytechnic Institute, reports that his department is now doing resident teaching, research, and extension work. Two new men have been added to the department staff recently; these are J. A. WALLER, instructor in power farming, and R. C. HUBBARD, fellow instructor in agricultural engineering, which makes a total of six people in the department at the present time. A total of 2500 people were instructed in the department of agricultural engineering during the past year. A student branch of the Society is now being organized at the V. P. I., in which it is estimated about twenty members will enroll at the start.

OSCAR W. SJOGREN, professor of agricultural engineering and head of the department at the University of Nebraska, received the professional degree of agricultural engineer from Iowa State College in June of this year.

C. W. SMITH, associate professor of agricultural engineering at the University of Nebraska, received his master's degree in physics at the University of Chicago last September. He also advises that his department is giving for the first time a course in mathematics to agricultural students.

JOHN SWENEHART, in charge of land clearing work in the department of agricultural engineering at the University of Wisconsin, has made more progress than usual during the past year to reclaim more cut-over acres for Wisconsin. Through the cooperative effort of the many organizations with which his staff is associated, Wisconsin farmers and land-clearing men have used over three million pounds of explosives this season, about half of which has been picric acid, a left-over war material distributed through the department of agricultural engineering at Wisconsin.

H. B. WALKER, professor of agricultural engineering and head of the department at the Kansas State Agricultural

College, is carrying on an investigation of the work of the agricultural engineering departments of the various state agricultural colleges which will be completed some time during the latter part of this year. Prof. Walker's department is also starting some investigational work on private sewage disposal plants which will cover a period of from five to ten years.

H. B. WHITE, assistant professor of farm buildings in the division of agricultural engineering, University of Minnesota, reports that his section is so very busy at this time that the project work pursued during the part of the year when class work is not so pressing is practically at a standstill at this season. The one hundred and twenty plans in the farm building series are proving a great help in the work with students and farmers. The farm buildings section was organized in the fall of 1918.

F. A. WIRT has resigned as professor of farm machinery at the University of Arkansas and has become associated with the J. I. Case Threshing Machine Company as editor of "The Case Eagle," the company's house organ. He will also have charge of dealer schools and other sales promotion work.

J. C. WOOLEY, professor of agricultural engineering and head of the department at the University of Missouri, reports that the Board of Regents of that institution has oked the plans for a new agricultural engineering building. The department of agricultural engineering is about to issue a bulletin entitled "The Preservation of Fence Posts," data for which covers a period of eight years. It brings out some very interesting information on the different methods of treatment. An experiment is just being completed on the draft of wagons on different kinds of roads. Other projects under way include the testing of farm light plants and an experiment on concrete fence posts. Prof. Wooley, in conjunction with Prof. Helm of the farm crops department, has completed a private project consisting of the designing and building of a pea and bean thresher attachment for the ordinary grain binder, on which an application for a patent has been made.

O. B. ZIMMERMAN has been appointed assistant to the manager of the experimental and engineering department of the International Harvester Company, charged especially with duties covering material specifications, standardization, engineering board procedure, special committees, engineering research, investigations, statistics and engineering society activities.

### Notice to A.S.A.E. Members

THE 1921 Transactions were mailed the first week in November. A few copies of the 1920 Transactions went out, by mistake, in that mailing. If you received two copies of the 1920 Transactions, the last one during the first part of November, notify the Secretary at once, and he will send you a copy of the 1921 Transactions.

### New Members of the Society

J. L. BUNTING, Lock Box 13, Napton, Missouri.  
EVERETT C. EASTER, Auburn, Alabama.

#### TRANSFER OF MEMBERSHIP GRADE

JOHN FRANKLIN BEYERLE, Bernville, Pennsylvania.  
(From Student to Associate)

W. A. CRUMLEY, Xenia, Ohio. From Student to Junior)

FRANK P. HANSON, Department of Farm Mechanics, University of Illinois, Urbana, Illinois. (From Junior to Associate.)

WAUBUN CLARENCE KREUGER, Department of Farm Mechanics, University of Tennessee, Knoxville, Tennessee.  
(From Student to Junior)

VERNE W. STAMBAUGH, Department of Agricultural Engineering, Iowa State College, Ames, Iowa. (From Student to Junior)

H. H. VARNEY, Twinsburg, Ohio. (From Student to Junior)

### Applicants for Membership

The following is a list of applicants for membership received since the publication of the October issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send pertinent information relative to the applicants for the consideration of the Council prior to election.

EARL A. BICKEL, 10 Interstate Building, Cedar Rapids, Iowa.

ALLEN C. MILLER, civil engineer, Northern California Bank of Savings Building, Marysville, California.

#### FOR TRANSFER OF MEMBERSHIP GRADE

FRANCIS GRAHAM MCCOLLISTER, Clarksburg, Ohio.

M. V. VAN HOUTEN, J. I. Case Threshing Machine Company, Peoria, Illinois.

### EMPLOYMENT SERVICE

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of AGRICULTURAL ENGINEERING. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Non-members, as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

The Secretary receives at frequent intervals bulletins from the Engineering Societies' Service Bureau, 29 West 39th Street, New York City, listing the "positions open" as reported by member societies. Copies of these bulletins are sent to the "men available" listed below, as soon as received.

#### Men Available

AGRICULTURAL ENGINEER wants position as experimental agricultural engineer or with some agricultural publication. Graduate, 1918, agricultural college of the University of Illinois. Was editor of the Illinois agricultural students publication in his senior year. For two years employed by an explosives manufacturer as agricultural sales and service man for the State of Wisconsin. At present associated with the land clearing department of the University of Wisconsin. Age 25, married, American. MA-101

MECHANICAL AND ELECTRICAL ENGINEER, graduate of Cornell University and Armour Institute, with nineteen years of practical experience in designing, manufacturing, and marketing gasoline engines, automobiles, motor trucks and tractors, having specialized particularly on internal-combustion motors and their application, prefers mechanical work cooperating with the different manufacturing and sales departments along the lines of sales engineering, or other work into which his qualifications would fit. MA-101

AGRICULTURAL ENGINEER wants position in southwest. Graduate of University of Illinois 1915; five years practical experience on Illinois farm with power equipment; two years in charge of the agricultural engineering department New Mexico College of Agriculture; considerable garage experience and service experience on unit power and light plants. Also one summer in Philadelphia battery service station. MA-106

AGRICULTURAL ENGINEER, graduate in mechanical engineering at Michigan Agricultural College, desires position teaching all kinds of farm machinery or automotive work, or son's farm-equipment manufacturer. Will be available April 1, 1922. Has served one year as instructor in tractors and trucks, and one year conducting service schools for a leading tractor manufacturer. Can furnish best of references. MA-110

AGRICULTURAL ENGINEER, graduate of Iowa State College 1920, with several years of practical experience farming with machinery and one year's teaching experience in high school, wants employment on a large farm or in college teaching of power farming. Twenty-five years of age. Married. MA-111

AGRICULTURAL ENGINEER, graduating from University of Missouri at the end of present semester (available January 1, 1923), would like position teaching agricultural engineering work or with some company manufacturing farm equipment. Age 23. Unmarried. MA-115

#### Positions Open

DRAFTSMAN who has had experience in designing and manufacturing threshing machinery with reliable well-established farm-machinery manufacturer in central Pennsylvania. PO-1.

DRAFTSMAN to assist in designing threshing machinery and gas tractors with well established manufacturer of farm machinery in the East. PO-2.

STUDENT FELLOWS OR INSTRUCTOR IN DRAINAGE, the department of soils of the Oregon State Agricultural College will be able to use two student fellows, one in pure soils and one in soil irrigation and drainage work, if they can be promptly located, or an instructor in drainage if fellows are now secured. Write W. L. Powers, chief in soils, Corvallis, Oregon. PO-3.



## Longer Life for Farm Buildings—

The economy of protecting structural lumber from decay by preservative treatment with Carbosota is so thoroughly established that most of the leading Agricultural Colleges are now actively advocating the practice in connection with all farm buildings.

And in order more clearly to emphasize the importance of wood preservation, several of these institutions are supplementing their pamphlets on the subject, by showing on all drawings of model buildings distributed to farmers exactly where and how to apply the Carbosota.

As the application of the preservative is really part of the building operation, we believe you will readily see the advantages of this plan, and we will gladly co-operate with you in putting it into practice.

If you will forward to our nearest office blue prints of your standard farm buildings, our technical experts will indicate on them the portions that should receive preservative treatment, together with estimate of the quantity of Carbosota re-



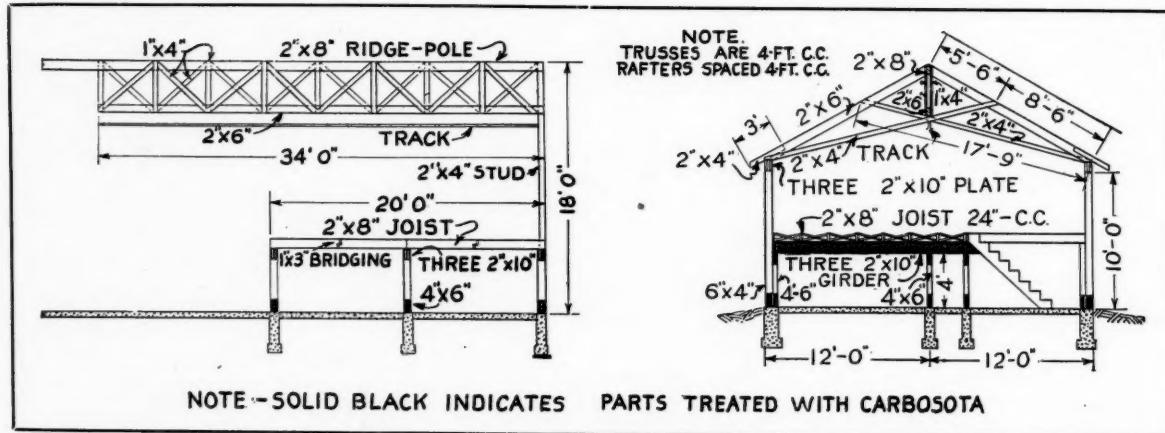
*This old tree may be conveniently located but it will prove to be a very expensive type of machine shed. (Photo courtesy of Purdue University, Lafayette, Ind.)*

quired and detailed instructions for applying. This service, and any other technical assistance or advice you may desire, are free for the asking.

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